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# New acoustic sensor for injection molds

**In-mold sensors are useful, but hardly applied because they are often too expensive, the space is limited or they are not robust enough (wires in mold!). That's our motivation!**

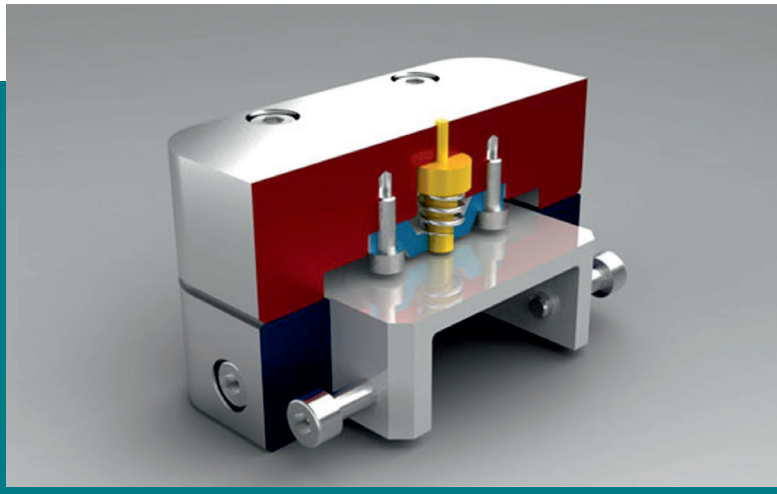
**We, the Chair of Polymer Processing in close collaboration with the Chair of Automation and the Industrial Liason Department have made it our task, to make in-mold sensors more robust and cost-effective to gain process information from the mold. Be a part of it!**

## Application of new sensor

- Detection of melt front for:
  - Definition of switchover point
  - Balancing of runner systems in multi-cavity molds
  - Checking of (in)complete filling
  - Trigger for cascade injection molding
- Potential detection of other unusual events in mold (related to wear or damage)

## Benefits for plastic part manufacturer

- Reduced scrap ⇨ cost reduction
- Tighter dimensional tolerances
- Robust process
- Process documentation
- Online quality control (checking of filled cavities)



## Advantages of acoustic sensor principle

- Purely mechanical principle in mold ⇨ reduced maintenance
- Wireless inside the mold ⇨ robust
- Sensitive sensor (microphone) on mold outside surface not subject to high melt temperature & pressure
- Multiple signals from multiple locations in the mold detectable with one sensor
- Fast response time
- Relatively cheap sensor (microphone)
- Minimal space requirement
- Can also be realized with modified existing ejector pins
- Existing molds can be upgraded with new sensor
- Sensor transferable between molds

## Further development

- Cooperation partner for product realization sought
- Type of cooperation to be defined
- Patents granted

## Patents

- Kukla, C.; Lucyshyn, T.; Rath, G.; Müller, F.: Acoustic noise sensing for controlling manufacture of a component part made of a flowable base material. European Patent number EP2807011, granted on 8.5.2017
- Kukla, C.; Lucyshyn, T.; Rath, G.; Müller, F.: Acoustic noise sensing for controlling manufacture of a component part made of a flowable base material. UK Patent number GB2498586, granted on 2.11.2016
- Further patent publications and patents pending in USA, China, Japan and Korea

**Curious how it works?**
Read onto the next page!

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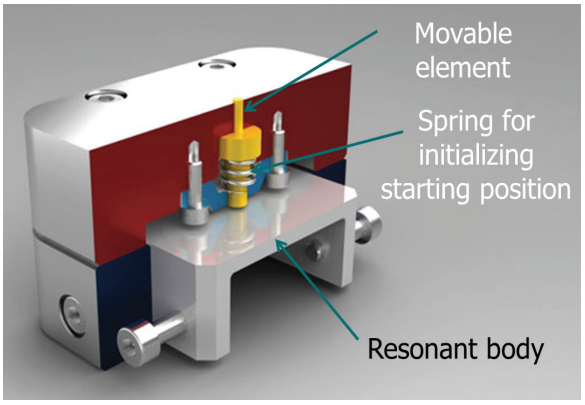
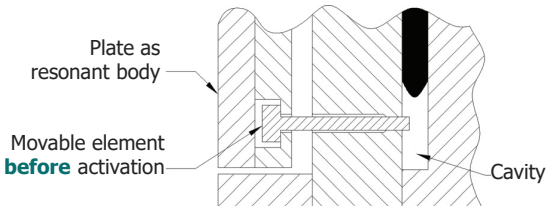
## Working principle

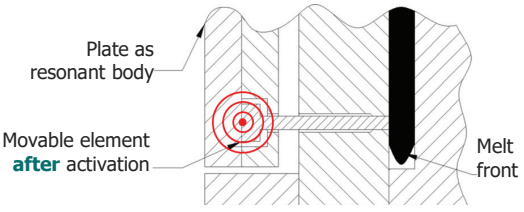
- Movable purely mechanical element (actuator) in mold (can be existing modified ejector pin)
- Acceleration of actuator by passing melt front
- Impact of element on mold ⇨ distinct sound
- Transfer of generated sound via solid-borne sound to mold outside surface
- Detection of generated sound by microphone
- Signal processing and filtering of generated sound
- Event of arriving melt front at defined position detected

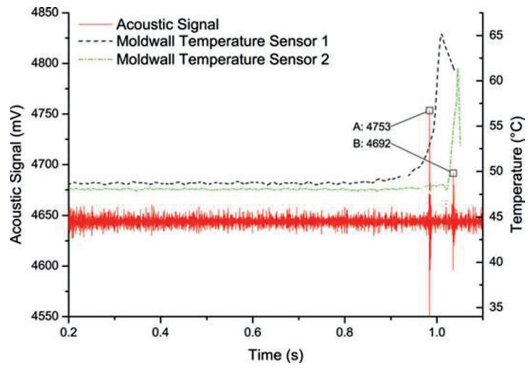



### Element position before arrival of melt front




### Activated element by passing melt front




## Proof of principle measurement

- Two-cavity mold with actuator in each cavity
- Two resonant bodies with different resonant frequencies to distinguish the signals from the two actuators
- One microphone on mold surface for sound detection of both signals
- Temperature sensors at same positions to validate the detection of melt front arrival
- Peak A of sound signal corresponds to rising signal of temperature sensor 1
- Peak B of sound signal corresponds to rising signal of temperature sensor 2

## Selected publications


- Müller, F.; Kukla, C.; Lucyshyn, T.; Holzer, C.: Hör auf dein Werkzeug, Kunststoffe 3 (2013), 31 - 33
- F. Müller, C. Kukla, T. Lucyshyn, C. Holzer: Wireless In-Mold Sensor for Injection Molding: A new Approach. Long Abstract in: PPS-28 Conference Proceedings. Pattaya (Thailand). 11.12. – 15.11.2012
- Müller, F.; Rath, G.; Lucyshyn, T.; Kukla, C.; Burgsteiner, M.; Holzer, C.: Presentation of a Novel Sensor Based on Acoustic Emission in Injection Molding. Journal of Applied Polymer Science 127/6 (2013), 4744 - 4749
- Müller, F.; Kukla, C.; Lucyshyn, T.; Harker, M.; Rath, G.; Holzer, C.: Wireless in-mold melt front detection for injection molding: A long-term evaluation. Journal of Applied Polymer Science 131/11 (2014), 40346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